FRACTURING REGULATION APPLIED

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INTRODUCTION

Since the drilling of the first commercial oil well in Titusville, Pennsylvania, in 1859,[1] a long and profitable history of fossil fuel development in America has unfolded. Throughout this history, there have been bursts of attention to both the positive and negative effects of domestic development.[2] Few energy issues have sparked as much recent attention, however, as a once little-known technique called hydraulic fracturing—also called fracing, fraccing, fracking, or hydrofracking.[3] Hydraulic fracturing exists in many forms, but its central purpose is to crack the formation surrounding an gas or oil well to encourage more gas or oil to flow through the well.[4] The

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1. *See* GROUND WATER PROT. COUNCIL, STATE OIL AND NATURAL GAS REGULATIONS DESIGNED TO PROTECT WATER RESOURCES 13 (2009), *available at* http://www.gwpc.org/e-library/documents/general/State%20Oil%20and%20Gas%20 Regulations%20Designed%20to%20Protect%20Water%20Resources.pdf; Ross H. Pifer, *Drake Meets Marcellus: A Review of Pennsylvania Case Law Upon the Sesquicentennial of the United States Oil and Gas Industry*, 6 TEX. J. OIL GAS & ENERGY L. 47, 48 (2010).

2. The blowout of BP's Macondo well in the Gulf of Mexico, for example, sparked a variety of studies and proposals for regulatory improvement. *See, e.g.*, DEEPWATER HORIZON STUDY GRP., THE MACONDO BLOWOUT 3RD PROGRESS REPORT (2010), *available at* http://ccrm.berkeley.edu/pdfs_papers/bea_pdfs/DHSG_ThirdProgressReportFinal.pdf; Hari M. Osofsky, *Multidimensional Governance and the BP Deepwater Horizon Oil Spill*, 63 FLA. L. REV. 1077, 1077 (2011).

3. *See* Christopher Kulander, *The States' Legal Framework: Texas/Louisiana Region American Law and Jurisprudence on Fracing*, at *1, *6 (Rocky Mountain Mineral L. Found., Paper 3A, 2011), *available at* Westlaw 2011 NO. 5 RMMLF-INST PAPER NO. 3A (noting that hydraulic fracturing is "known colloquially as 'fraccing,' 'fracking,' or 'fracing'"); Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 6 (Tex. 2008) ("'fracing,' as the process is known in the industry"); Hannah Wiseman, *Regulatory Adaptation in Fractured Appalachia*, 21 VILL. ENVTL. L.J. 229, 233 n.22 (2010) (documenting different terms used to describe hydraulic fracturing).

4. The technique also expands existing fractures in formations. *See* U.S. ENVTL. PROT.

technologies used to coax open these cracks in the formation vary widely; the common technique of hydraulic fracturing in coalbeds,[5] for example, is substantially different from fracturing in densely-packed shale and tight sands formations.[6] The type of fracturing that has attracted the strongest recent interest from media organizations, academics, agencies, and politicians is the process applied to shales and tight sands, which is called "slickwater" (or slick water) fracturing.[7]

Energy companies developed slickwater fracturing in the 1990s in the Barnett Shale of Texas and have since transferred the technique to shales around the country.[8] In most cases, developing a shale well requires construction of a well pad, which is the site that hosts the well and associated equipment; drilling and casing the well,

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AGENCY (EPA), EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIRS 3-4 (2004), *available at* http://water.epa.gov/type/groundwater/uic/upload/completestudy.zip.

5. *See id.* at 3-2, 3-11 (noting that 13,973 coalbed methane wells were producing in 2000 and describing the process of fracturing a well, which requires drilling a production well in the coalbed, injecting a "median average injection volume" of 57,500 gallons of water per well, along with chemicals and fine sand for proppant).

6. *See* R.R. COMM'N OF TEX., WATER USE IN THE BARNETT SHALE, http://www.rrc.state.tx.us/barnettshale/wateruse_barnettshale.php (last visited Mar. 22, 2012) ("Slick water fracking of a vertical well completion can use over 1.2 million gallons (28,000 barrels) of water, while the fracturing of a horizontal well completion can use over 3.5 million gallons (over 83,000 barrels) of water."); N.Y. DEP'T OF ENVTL. CONSERVATION, REVISED DRAFT SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM, at ES-8 (2011), *available at* http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf ("It is estimated that 2.4 million to 7.8 million gallons of water may be used for a multi-stage hydraulic fracturing procedure in a typical 4000-foot lateral wellbore."). Fracturing is necessary to produce gas or oil from shales and tight sands. *See* Kulander, *supra* note 3, at 4.

7. *See* EPA, *supra* note 4, at 4-8. For additional information on horizontal drilling, which typically precedes this process, see Jeffrey C. King, *Selected Re-Emerging and Emerging Trends in Oil and Gas Law as a Result of Production from Shale Formations*, 18 TEX. WESLEYAN L. REV. 1, 3 (2011) ("Hydraulic fracturing is generally coupled with horizontal drilling so that as much of the rock as possible is exposed to the fracture stimulation."); PA. DEP'T OF ENVTL. PROT., HYDRAULIC FRACTURING OVERVIEW 1 (2010) [hereinafter HYDRAULIC FRACTURING OVERVIEW], *available at* http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/MarcellusShale/DEP%20Fracing%20overview.pdf ("Horizontal well drilling and completion is another technology used in the Marcellus Formation to increase the productivity of a gas well by maximizing the length of the wellbore through the target formation.").

8. *See* R.R. COMM'N OF TEX., WATER USE, *supra* note 6 ("In 1997, the first slick water frac (or light sand frac) was performed and found to be very successful in stimulating the Barnett Shale."). Slickwater fracturing is differentiated from water fracturing because it uses both large volumes of water and a gel or other friction reducer. Jay A. Rushing & Richard B. Sullivan, *Improved Water-Frac Increases Production*, E&P, Oct. 12, 2007, http://www.epmag.com/archives/features/661.htm.

often using horizontal drilling techniques;[9] punching holes in small segments of the well far beneath the surface; and pumping a solution of water and chemicals down the well at high pressure.[10] This process forces the solution out through the perforations in the well, fracturing the surrounding formation and expanding any existing fractures.[11] While conducting a slickwater fracturing operation, operators also pump a proppant, such as sand, into the well to prop open the fractures and allow oil or gas to flow up through the well's production casing—a tube inserted into the well for the purpose of isolating the oil or gas and allowing it to flow up the well.[12]

The specific technique of slickwater fracturing varies substantially among formations and among wells within one formation. Engineers at well sites drill different well depths, fracture wells at different pressures, and apply a variety of chemical types and quantities based on many factors, including the density and composition of the formation being fractured.[13] Despite differences

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9. PA. DEP'T OF ENVTL. PROT., DRILLING FOR NATURAL GAS IN THE MARCELLUS SHALE FORMATION 1 (2008), *available at* http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/MarcellusShale/MarcellusFAQ.pdf (stating, partially incorrectly, that fracturing the Marcellus Shale "requires" horizontal drilling); J. DANIEL ARTHUR & MARK LAYNE, HYDRAULIC FRACTURING CONSIDERATIONS FOR NATURAL GAS WELLS OF THE MARCELLUS SHALE 7–8 (2008), *available at* http://www.dec.ny.gov/docs/materials_minerals_pdf/GWPCMarcellus.pdf (describing both horizontal and vertical completions in the Marcellus and explaining that horizontal wells are more productive); U.S. DEP'T OF ENERGY, SEC'Y OF ENERGY ADVISORY BD., SHALE GAS PRODUCTION SUBCOMMITTEE 90-DAY REPORT 8 (2011) [hereinafter U.S. DEP'T OF ENERGY, 90-DAY REPORT], *available at* http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf (noting the importance of horizontal drilling combined with fracturing to develop shales). Horizontal drilling involves an operator drilling straight down into a formation and then deviating the drill bit. *See* Joseph H. Frantz, Jr., *Natural Gas, Range Resources, and the Marcellus Shale*, at *1, *4 (Rocky Mountain Mineral L. Found., Paper 2, 2010), *available at* Westlaw 2010 NO. 5 RMMLF-INST PAPER NO. 2. Multiple horizontal wells can be drilled from one pad, with the horizontal portions of the wellbores radiating away from each other. Thomas Swartz, *Hydraulic Fracturing: Risks and Risk Management*, 26 NAT. RES. & ENV'T 30, 30 (2011).

10. *See* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 5-91 to -97 (describing hydraulic fracturing procedure); HYDRAULIC FRACTURING OVERVIEW, *supra* note 7 (describing the slickwater fracture process).

11. N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 5-95.

12. *Id.*; *see* GROUND WATER PROT. COUNCIL, *supra* note 1, at 20 (explaining that the production casing is inserted into the "target formation" (the formation from which oil or gas is produced) or the top of the target formation).

13. *See, e.g.*, N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 5-30 (noting that at the drilling stage, factors such as "formation depth and thickness, mechanical and physical factors associated with the well construction program, production experience in the area, [and] lease position and topography" affect the drilling pattern); *cf. id.* at 5-88 (noting that "for any given area and formation, hydraulic fracturing design is an iterative process").

among specific slickwater fracturing techniques, the process as a whole has fundamentally changed American oil and gas production. It has made fracturing the norm in gas development,[14] encouraged new horizontal drilling techniques,[15] and enabled abundant production of shale oil in certain areas of the country.[16] In reshaping the domestic energy landscape, the technique has introduced several new stages to the development process, requiring larger volumes of water[17] and new types of chemicals.[18] Just as importantly, it has allowed operators to drill thousands of new oil and gas wells, thus expanding the impacts of traditional drilling to new sites.[19]

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14. Approximately ninety percent of all new gas wells are fractured. *See* Ben Casselman & Russell Gold, *Drilling Tactic Unleashes a Trove of Natural Gas—And a Backlash*, WALL ST. J., Jan. 21, 2010, at A1, *available at* http://www.uppermon.org/news/Other/WSJ-Backlash-21Jan10.html.

15. Kulander, *supra* note 3, at 5 ("The prevalence of horizontal drilling has . . . increased the importance of fracing as boreholes can now traverse through a much longer portion of a targeted horizon instead of the interval covered by vertical or slant drilling, making the return to the operator in increased production worth the cost of mobilization of a fleet of fracing equipment."); U.S. DEP'T OF ENERGY, 90-DAY REPORT *supra* note 9, at 8 (noting that "the combination of two technologies working together—hydraulic fracturing and horizontal drilling—made shale gas commercial" in 2002 and 2003).

16. *See* U.S. ENERGY INFO. ADMIN., TECHNOLOGY-BASED OIL AND NATURAL GAS PLAYS: SHALE SHOCK! COULD THERE BE BILLIONS IN THE BAKKEN? 1 (2006), *available at* ftp://ftp.eia.doe.gov/features/ngshock.pdf (describing "highly productive oil field discoveries within the Bakken Formation" enabled by horizontal drilling and fracturing).

17. *See* R.R. COMM'N OF TEX., WATER USE, *supra* note 6 (estimating that a horizontal well that is fractured requires more than 3.5 million gallons of water); MARCELLUS SHALE ADVISORY COMM'N, FINAL REPORT 17 (2011), *available at* http://files.dep.state.pa.us/PublicParticipation/MarcellusShaleAdvisoryCommission/MarcellusShaleAdvisoryPortalFiles/MSAC_Final_Report.pdf (noting that "much larger quantities of water are required for gas shale"); N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 5-93 to -94 (estimating that hydraulically fracturing a single shale well requires between 2.5 and 7.8 million gallons of water).

18. *See* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 5-42 to -48 (listing chemical additives in hydraulic fracturing fluids); U.S. HOUSE OF REPRESENTATIVES, COMM. ON ENERGY AND COMMERCE MINORITY STAFF, CHEMICALS USED IN HYDRAULIC FRACTURING 13–30 (2011), *available at* http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf (listing hundreds of chemical components that were used in various hydraulic fracturing treatments between 2005 and 2009). Fracturing prior to the 1990s often used much larger quantities of sand and gels in lieu of large volumes of water. *See* Rushing & Sullivan, *supra* note 8.

19. *See, e.g.*, PA. DEP'T OF ENVTL. PROT., WELLS DRILLED, *available at* http://www.dep.state.pa.us/dep/deputate/minres/oilgas/2011%20Wells%20Drilled.gif (last visited Mar. 23, 2012) (showing 1751 wells drilled in the Marcellus Shale from January through November, 2011); R.R. COMM'N OF TEX., NEWARK EAST (BARNETT SHALE) DRILLING PERMITS ISSUED (1993–2010), http://www.rrc.state.tx.us/barnettshale/drillingpermitsissued.pdf (last visited Mar. 23, 2012) (showing 4145 permits issued during the peak Barnett drilling year of 2008); *cf.* Kulander, *supra* note 3, at 5 (noting that about 35,000 wells are fractured annually). Not all of these 35,000 wells, of course, are newly-drilled wells.

As fracturing has allowed more wells in new formations to be drilled, the sheer increase in well numbers has led to a range of environmental effects that can begin long before the actual fracturing occurs. As with any type of oil or gas well, a developer must construct a well pad and a road to the pad,[20] drill the well,[21] store drilling wastes at the surface in a pit or tank, and then dispose of these wastes.[22] Water for drilling must be withdrawn from surface or underground sources, or, if not withdrawn on site, piped or trucked in and then temporarily stored.[23] As described in more detail in part I, drilling fluids and muds may spill on the surface of well pads, produced water may spill during transfer or leak from a surface pit, and oil from drilling equipment may leak onto well pads.[24] Improperly cased wells may also leak methane at the drilling stage, causing methane to migrate into soil and water sources.[25]

Fracturing expands these familiar risks by enabling more development and adds new ones unique to fracturing-related activities. The horizontal drilling that often precedes fracturing can concentrate certain environmental effects like air pollution, but can also have positive impacts including less surface disturbance, reduced erosion, and avoidance of sensitive habitats.[26] Before fracturing

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20. AM. PETROLEUM INST., FREEING UP ENERGY: HYDRAULIC FRACTURING: UNLOCKING AMERICA'S NATURAL GAS RESOURCES 6 (2010), http://www.api.org/policy/exploration/hydraulicfracturing/upload/HYDRAULIC_FRACTURING_PRIMER.pdf (describing the "land disturbance" necessary to develop a shale gas well); N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 5-135 (describing access road and well pad construction).

21. AM. PETROLEUM INST., *supra* note 20, at 6 (describing the "four or five weeks of rig work" that precede well fracturing).

22. JOSEPH DANCY, ROCKY MOUNTAIN MINERAL L. FOUND., ENVIRONMENTAL REGULATION OF THE OIL AND GAS INDUSTRY II, CHAPTER 5: SOLID WASTE MANAGEMENT AND ENVIRONMENTAL REGULATION OF COMMONLY ENCOUNTERED OIL FIELD WASTES at *1, *3 (1994), *available at* Westlaw 35A RMMLF-INST 5 (1994).

23. *Cf.* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at ES-9 ("Water for hydraulic fracturing may be obtained by withdrawing it from surface water bodies away from the well site or through new or existing water-supply wells drilled into aquifers.").

24. Hannah Wiseman, *State Enforcement of Shale Gas Development Regulations* (Univ. of Texas Energy Inst., Draft White Paper, Jan. 2012), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1992064.

25. *See, e.g.*, EAST RES., INC., DELCIOTTO NO. 2, SUBSURFACE NATURAL GAS RELEASE REPORT ROARING BRANCH, MCNETT TOWNSHIP, LYCOMING COUNTY, PENNSYLVANIA 10–11 (Sept. 18, 2009) (contained in October 7, 2011, response to Right-to-Know request 4400-11-170) (describing gas in soil, natural springs, and wells, some of which was naturally occurring and some of which likely leaked from an improperly-cased well) (on file with DUKE ENVTL. L. & POL'Y F.).

26. I am grateful to Professor Bruce Kramer for his description of the positive and

begins, fracturing chemicals must be transported to well sites;[27] these fluids can spill from trucks during transport[28] or transfer.[29] Operators must withdraw significantly more water for slickwater fracturing than for conventional natural gas drilling or other fracturing techniques, requiring approximately one to seven million gallons for each fracturing treatment.[30] Expanded water use[31] can affect water quality and reduce stream flow, thereby negatively impacting stream biota[32] and reducing long-term supply.[33] Hoses moved from one water withdrawal site to another can introduce disease spores and invasive species to surface waters.[34] Shipment of both water and chemicals to

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negative effects of horizontal drilling in his comments on my Energy Institute paper, *supra* note 24. *See also* NAT'L PARK SERV., POTENTIAL DEVELOPMENT OF THE NATURAL GAS RESOURCES IN THE MARCELLUS SHALE 8 (2008), *available at* http://www.eesi.psu.edu/news_events/EarthTalks/2009Spring/materials2009spr/NatParkService-GRD-M-Shale_12-11-2008_view.pdf (noting that horizontal drilling "could result in fewer impacts than conventional vertical wells due to greater flexibility in well location"); U.S. DEP'T OF ENERGY, ENVIRONMENTAL BENEFITS OF ADVANCED OIL AND GAS EXPLORATION AND PRODUCTION TECHNOLOGY 34 (1999) [hereinafter U.S. DEP'T OF ENERGY, ENVIRONMENTAL BENEFITS], *available at* http://www.fe.doe.gov/programs/oilgas/publications/environ_benefits/env_benefits.pdf (describing the benefits of horizontal drilling, including producing more resources with fewer wells).

27. NAT'L PARK SERV., *supra* note 26, at 9 (estimating that transport of "completion fluids and materials" requires somewhere between 100 and 1000 truck trips to a well site).

28. *See* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 6-315 ("Transportation of any hazardous materials always carries some risks from spills or accidents. Hazardous materials are moved daily across the state without incident, but the additional transport resulting from horizontal drilling poses an additional risk, which could be an adverse impact if spills occur.").

29. *Id.* at 5-81 (describing chemical transfer from trucks).

30. *See supra* note 6.

31. Much of the use is consumptive in that it fails to return the used water to the local basin. *See* SUSQUEHANNA RIVER BASIN COMM'N, ACCOMMODATING A NEW STRAW IN THE WATER: EXTRACTING NATURAL GAS FROM THE MARCELLUS SHALE IN THE SUSQUEHANNA RIVER BASIN, at 1 n.2 (2009) (citing 18 CFR § 806.3 (2009)), *available at* http://www.srbc.net/programs/docs/Marcellus%20Legal%20Overview%20Paper%20%28Beaudy%29.pdf.PDF.

32. N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 6-2 to -3.

33. *Cf.* R.R. COMM'N OF TEX., WATER USE, *supra* note 6 ("Increasing water use due to growing population, drought, and Barnett Shale development has heightened concerns about water availability in North-Central Texas."). *But see* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 6-4 (noting that "projected water withdrawals and consumptive use of water [for high-volume hydraulic fracturing] are modest relative to overall water withdrawals in New York").

34. *See* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 6-4 ("Transporting water from the water withdrawal location for use off-site . . . can transfer invasive species from one water body to another via trucks, hoses, pipelines, and other equipment."); COLO. OIL & GAS CONSERVATION COMM'N, Rule 1204(a)(2), 2 C.C.R. 404-1 § 1204(a)(2) (2009) ("In designated Cutthroat Trout habitat . . . operators shall disinfect water suction hoses and water transportation tanks withdrawing from or discharging into surface waters . . . used previously in

well sites expands truck trips to the site, causing damage to roads and local traffic problems.[35] Fracturing also increases the pressure on the well, which increases the risks of casing failure.[36] Finally, during and after fracturing, chemicals can spill from tanks, and flowback water—fluid that flows back up out of the well after fracturing—can be mishandled.[37]

States have taken a variety of approaches to address these potential effects. Several states have begun updating their regulations, for example, to require stronger casing, to prevent leakage of oil and gas wastes from surface pits, and to prohibit the use of certain chemicals in fracturing.[38] Furthermore, states continue to apply new and preexisting regulations by inspecting well sites, noting violations, and, in some cases, by taking enforcement action, such as issuing administrative orders, entering into consent orders, and imposing penalties.[39] This article addresses these latter inspection and enforcement activities, exploring how state agencies have applied regulations to oil and gas operators.

Part I briefly introduces state regulatory programs and provides examples of the types of violations that states have noted at oil and

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another river, lake, pond, or wetland" in order to control the introduction of disease spores.).

35. NAT'L PARK SERV., *supra* note 26, at 8–9; PENN STATE COLL. OF AGRIC. SCI., MARCELLUS SHALE: WHAT LOCAL GOVERNMENT OFFICIALS NEED TO KNOW 11 (2008), *available at* http://downloads.cas.psu.edu/naturalgas/pdf/MarcellusShaleWhatLocalGovernmentOfficialsneedtoknow.pdf.

36. *Cf.* N.Y. DEP'T OF ENVTL. CONSERVATION, *supra* note 6, at 6-55 ("During hydraulic fracturing operations, the pressure in the well is greater than the pressure in the formation . . . .").

37. Although this article focuses on the potentially negative environmental effects of fracturing and states' application of regulations to activities that can cause these effects, it is important to note several positive environmental developments in addition to the benefits of drilling multiple wells on a pad. For a summary of these benefits, see U.S. DEP'T OF ENERGY, ENVIRONMENTAL BENEFITS, *supra* note 26.

38. *See, e.g.*, N.M. CODE R. § 19.15.17.10 (2008) (requiring lined pits and, in some situations, steel tanks for storing oil and gas wastes).

39. The enforcement scheme for state environmental or oil and gas laws is complex and varies substantially. States often divide enforcement activity into two broad categories of "formal" and "informal" enforcement. *See, e.g.*, FLA. DEP'T OF ENVTL. PROT., ENFORCEMENT MANUAL 12 (Revised Dec. 2004), *available at* http://www.dep.state.fl.us/legal/Enforcement/chapters/chapter2.pdf; *Oil and Gas Regulatory Enforcement*, OHIO DIV. OF OIL AND GAS RES. MGMT., http://www.ohiodnr.com/mineral/enforcement/tabid/17872/Default.aspx (last visited Apr. 10, 2012). For examples of the variety of the types of enforcement actions taken, see *General Users Guide to the COGCC Hearing Process,* COLO. OIL & GAS CONSERVATION COMM'N, *available at* http://cogcc.state.co.us/Hearings/HearingGuide.htm; MICH. DEP'T OF ENVTL. QUALITY, COMPLIANCE AND ENFORCEMENT PROCEEDINGS FACT SHEET, *available at* http://www.michigan.gov/documents/deq/ogs-compliance-factsheet_262981_7.pdf.

gas sites since shale or tight sands development became more common. Part II describes the types of enforcement actions that states have taken in response to these violations.[40] It is important to note that the violations and enforcement actions explored here are not comprehensive because full data sets from each state were unavailable at the time of publication. It is also important to recognize that the violations and enforcement actions described are associated with a variety of well types—Antrim Shale wells in Michigan, for example, require substantially different fracturing and drilling techniques than Barnett Shale wells in Texas.[41] With these caveats in mind, the data described paint a preliminary picture of regulations beyond their text, showing that states' notations of violations of environmental and oil and gas laws and resulting enforcement actions vary substantially.

I. STATE REGULATION AND ENFORCEMENT ACTIVITY AT SHALE GAS AND TIGHT SANDS WELL SITES

Due to several federal exemptions for oil and gas development and fracturing,[42] states bear the primary responsibility for regulating shale gas development. State regulation has garnered enhanced attention as drilling and fracturing have boomed, inspiring both praise and critique. Some commentators have focused on the exemptions from federal regulation that oil and gas operators enjoy and have argued that applicable federal regulation is inadequate to protect health and the environment.[43] Others have proposed that

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40. The violations described in Part I include all instances where inspectors noted a violation or issued a notice of violation.

41. *See generally* HALLIBURTON, U.S. SHALE GAS, AN UNCONVENTIONAL RESOURCE, UNCONVENTIONAL CHALLENGES 2–5 (2008), *available at* http://www.halliburton.com/public/solutions/contents/Shale/related_docs/H063771.pdf (describing different shales (not including the Antrim) and how development practices in the shales differ; introducing the Antrim Shale).

42. For discussion of federal regulation and exemptions, see James R. Cox, *Revisiting RCRA's Oilfield Waste Exemption as to Certain Hazardous Oilfield Exploration and Production Wastes*, 14 VILL. ENVTL. L.J. 1 (2003). *See also* Wiseman, *Regulatory Adaptation*, *supra* note 3, at 242–47 (describing the exemption of fracturing (with the exception of fracturing with diesel fuel) from the definition of "underground injection" under the Safe Drinking Water Act, and the more general exemption of oil and gas exploration and production (or "E&P") wastes from the hazardous waste portion of the Resource Conservation and Recovery Act); *id.* at 242 (explaining that the Comprehensive Environmental Response, Compensation, and Liability Act does not apply to spills of petroleum and gas); Hannah Wiseman, *Trade Secrets, Disclosure, and Dissent in a Fracturing Energy Revolution*, 111 COLUM. L. REV. (SIDEBAR) 1, 5–6 (2011) (explaining that the Emergency Planning and Community Right-to-Know Act does not require reporting of annual releases of toxic substances from oil and gas sites).

43. *See, e.g.*, Mark A. Latham, *The BP Deepwater Horizon: A Cautionary Tale for CCS,*

municipalities, although limited in some cases by state preemption, must improve oversight of drilling and fracturing.[44] With all the attention paid to regulatory content, however, it is easy to forget that, as thousands of new gas wells are developed each year, state agencies are on the ground, shaping the contours of these new and existing regulations through their application. To understand how existing regulations operate—and how proposed regulations might play out—it is necessary to develop a better understanding of the implementation of regulations by states. Regulations that appear strong as written may have little effect as enforced while seemingly inconsequential regulations may meaningfully influence development if broadly interpreted and frequently enforced by states. This part provides a glimpse into regulations of well development and fracturing, as applied by state agencies, first by introducing state regulatory programs and then by describing the types of violations noted at shale gas and tight sands sites over the last decade.

A. State Regulation of Shale Gas and Tight Sands Development

In most states, one agency—either an oil or gas or environmental agency—has primary authority over oil and gas development. Many state oil and gas commissions, which originally held this authority, had mandates to preserve these resources and protect the rights of neighboring owners, whose resources could be drained.[45] In addition to this core conservation mandate, limited regulation for basic safety

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Hydrofracking, Geoengineering and Other Emerging Technologies with Environmental and Human Health Risks, 36 WM. & MARY ENVTL. L. & POL'Y REV. 31, 58–59 (2011) (criticizing the Safe Drinking Water Act exemption, concluding that "the current federal regulatory approach is insufficient to protect human health and the environment from the risks associated with hydraulic fracturing," and observing that the government has taken an "after-the-fact, piecemeal approach to regulation" that has "turned the precautionary principle on its head"); Elizabeth Burleson, *Cooperative Federalism and Hydraulic Fracturing: A Human Right to a Clean Environment,* _ CORNELL J.L. & PUB. POL'Y _ (forthcoming 2013), draft available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2007234 (noting that "[r]egulatory coordination is lacking with regard to unconventional natural gas extraction and its health/environmental impacts"). *But see* Kevin J. Garber et al., *Water Sourcing and Wastewater Disposal: Two of the Least Worrisome Aspects of Marcellus Shale Development in Pennsylvania*, 13 DUQ. BUS. L.J. 169, 172 (2011) (expressing some optimism about updated EPA and state regulations for wastewater management, the development of industry best practices, and other responses to risks).

44. *See generally* John M. Smith, *The Prodigal Son Returns: Oil and Gas Drillers Return to Pennsylvania with a Vengeance: Are Municipalities Prepared?*, 49 DUQ. L. REV. 1 (2011).

45. *See* GROUND WATER PROT. COUNCIL, *supra* note 1, at 14 ("Throughout the period 1946 to 1960, most oil and gas producing states established a regulatory agency to enforce oil and gas conservation practices.").

also emerged; states required the plugging of wells,[46] for example, and promulgated basic well construction requirements to protect groundwater.[47] As environmental concerns expanded, so too did the responsibility of state agencies to respond to the environmental effects of oil and gas development.

Today, the state agency with primary authority over oil and gas development regulates issues such as the casing of wells to prevent groundwater contamination, the construction and maintenance of surface pits in which oil and gas waste is stored, and the disposal of oil and gas waste.[48] Frequently, a second agency has limited jurisdiction over certain issues, such as air quality or the accumulation of low levels of radiation on oil and gas equipment that results from drilling and its associated wastes.[49]

The capacity of these agencies to execute the regulations assigned to them varies widely. Based on a survey of a limited number of state agencies, the total number of field inspectors employed in 2011 ranged from approximately four in Maryland to twenty-eight in Ohio and eighty-four in Pennsylvania.[50] Texas, a

46. An operator plugs a well by pumping cement down it. If done properly, this seals the well, preventing water and other substances from leaking into it and gas or oil from leaking out. R.R. COMM'N OF TEX., WELL PLUGGING PRIMER 6–7 (2008), *available at* http://www.rrc.state.tx.us/forms/publications/plugprimer1.pdf.

47. GROUND WATER PROT. COUNCIL, *supra* note 1, at 13.

48. *Id.* at 15 (noting that "[m]any states formed separate departments to administer overall environmental regulations because of the programmatic shift in emphasis toward protection of water and land resources" in oil and gas drilling).

49. In Texas, for example, the Railroad Commission has the bulk of regulatory authority over oil and gas wells, but the Texas Commission on Environmental Quality (TCEQ) administers air quality regulations at well sites. *See* R.R. COMM'N OF TEX., BARNETT SHALE INFORMATION, http://www.rrc.state.tx.us/barnettshale/index.php (last visited Mar. 23, 2012) (explaining that the Commission does not have jurisdiction over "roads, traffic, noise, odors, leases, pipeline easements, or royalty payments" and that local governments and other state agencies control roads and traffic issues, while the TCEQ addresses "odors and air contaminants"). *See also* Hannah Wiseman & Francis Gradijan, *Regulation of Shale Gas Development*, at 114–15 (Univ. of Texas Energy Inst., Draft White Paper, Oct. 2011), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1953547 (describing how several different agencies often have responsibility for various forms of naturally occurring radioactive materials from oil and gas development). Naturally occurring radioactive materials (NORM) can accumulate at oil and gas sites (and equipment that handles these materials can pick up low levels of radioactivity) because portions of the drilled formation, which are naturally radioactive, can be deposited "on well casing and in downhole equipment." The Need and Desirability to Issue an Order Establishing Particular Requirements for Plugging of Wells Where Naturally Occurring Radioactive Material (NORM) May be Present, MICH. DEP'T NATURAL RES. ORDER NOS. 3-6-92 & (M) 1-6-92, at 1 (1992), *available at* http://www.michigan.gov/documents/deq/ogs-oilandgas-sow-3-6-92_261340_7.pdf.

50. Wiseman, *State Enforcement*, *supra* note 24, at 13–14.

historically active oil and gas state, employed 125 inspectors in 2008 at its Railroad Commission—the agency with primary regulatory authority over oil and gas sites in the state.[51] The number of staff employed is largely influenced by the number of wells: Maryland, with no hydraulically fractured shale wells to date,[52] would reasonably expect fewer incidents than would the Texas Railroad Commission and would therefore hire fewer staff. Inspection and enforcement capacity is also affected by state budgets, agency priorities, and political directives from governors and legislatures. In Pennsylvania, for example, the Department of Environmental Protection—the agency tasked with enforcing most state regulations of oil and gas wells—increased the fees attached to the permit that each operator must obtain before drilling a well and used the money to hire more staff.[53] The permit fee rose from $100 to an average of approximately $2850,[54] and the total staff increased from 90 to 202, with 84 of these staff members devoted to field inspections.[55] The Texas Railroad Commission, in contrast, has had to oversee expanding development with decreasing levels of funding and staffing.[56]

B. Preliminary Data on Violations

Some state agencies tasked with executing environmental regulations—often in addition to ensuring oil and gas conservation and protecting mineral rights—have been overwhelmed by the pace and volume of new well development.[57] In Texas, in 2010 alone, 2157 drilling permits were issued for the shale,[58] and between 2010 and 2011, the Texas Commission on Environmental Quality, which is primarily responsible for air quality issues at well sites, received approximately 535 complaints associated with Barnett Shale

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51. R.R. COMM'N OF TEX., SELF-EVALUATION REPORT 97 (2009), *available at* http://www.sunset.state.tx.us/82ndreports/rct/ser.pdf.

52. Telephone interview by Matthew Pena with Wes McBride, Engineer, Md. Dep't of the Env't, Mining Program (July 15, 2011).

53. MARCELLUS SHALE ADVISORY COMM'N, *supra* note 17, at 65.

54. *Id.*

55. *Id.* at 66.

56. R.R. COMM'N OF TEX., SELF-EVALUATION REPORT, *supra* note 51, at 14.

57. *See, e.g.*, Mike Soraghan, *Protecting Oil from Water – The History of State Regulation*, GREENWIRE, Dec. 14, 2011, http://www.eenews.net/public/Greenwire/2011/12/14/1 (quoting Randy Huffman, Secretary, West Virginia Department of Environmental Protection, "Quite frankly, our regulatory structure is not prepared to deal with it. . . . All of a sudden we have, basically, a brand new industry that shows up on the scene. We see a lot of things, that quite frankly, the state was not prepared for.").

58. R.R. COMM'N OF TEX., DRILLING PERMITS ISSUED, *supra* note 19.

development.[59] In Pennsylvania, the number of wells drilled in the Marcellus Shale skyrocketed from 195 in 2008[60] to 1751 in 2011.[61]

The increased number of new wells comes, in some cases, with a correspondingly high number of violations and enforcement actions, although this varies considerably among states. In Pennsylvania in 2011, for example, the Department of Environmental Protection conducted 10,307 site inspections of Marcellus Shale wells, noted violations at 6.3% of inspected sites for a total of 1189 violations, and took 213 enforcement actions.[62] The Texas Railroad Commission conducted 120,866 site inspections of all oil and gas sites in the state (not just Barnett Shale sites[63]), noted environmental violations at 18.5% of these sites, and referred 535 violations for enforcement action.[64] Total enforcement actions at fractured well sites in Texas in 2010, the latest year for which a full data set was available, were comparatively small, at only five.[65] A number of factors could

59. Wiseman, *State Enforcement*, *supra* note 24, at 25.

60. PA. DEP'T OF ENVTL. PROT., 2008 WELLS DRILLED, http://www.dep.state.pa.us/dep/deputate/minres/oilgas/BOGM%20Website%20Pictures/2008/2008%20Wells%20Drilled.jpg (last visited Mar. 23, 2012).

61. PA. DEP'T OF ENVTL. PROT., WELLS DRILLED, *supra* note 19.

62. PA. DEP'T OF ENVTL. PROT., OFFICE OF OIL AND GAS MANAGEMENT COMPLIANCE REPORT (Query Range: 01/01/2011 to 12/31/2011) [hereinafter PA. 2011 VIOLATIONS AND ENFORCEMENTS] (downloaded Mar. 23, 2012), http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/OG_Compliance (spreadsheet on file with DUKE ENVTL. L. & POL'Y F.). For the purposes of this article, "enforcement" refers to any formal agency response to a notation that a violation occurred; enforcements identified for this article included administrative orders, agreed orders, agency issuance of penalties, and agency directives for remedial action at well sites. A violation, in turn, is defined as any instance in which a document noted a violation, issued a notice of violation, or identified the statute or regulation violated at a well site. This line is, by necessity, blurry. Often, a state might consider a notice of violation to be an informal enforcement action (not just a violation), as this notice often would be followed either by the violator's voluntary correction of the violation or an administrative order. *See supra* note 39.

63. The Texas dataset described herein includes, presumably, a number of wells that were never hydraulically fractured because it includes all wells in the state, including conventional wells outside of the Barnett Shale.

64. R.R. COMM'N OF TEX., SELF EVALUATION REPORT, *supra* note 51, at 90–91.

65. *See* Hannah Wiseman, TEXAS VIOLATIONS AND ENFORCEMENTS (2011), at PERMIT NOS. 31137, 0658516, 0552969, 0672613, 0683121 [hereinafter TEX. VIOLATIONS AND ENFORCEMENTS] (spreadsheet compiling violation and enforcement data provided by the Texas Railroad Commission in response to author's query) (spreadsheet on file with DUKE ENVTL. L. & POL'Y F., original data on file with author). Raw data inputted into the spreadsheet are from hard copy enforcement files provided to the author by Leslie Savage, Chief Geologist, Oil and Gas Division, Railroad Comm'n of Tex. Additionally, an enforcement case for Permit no. 0682577 began in 2010 but was reassigned and completed in 2011. Enforcement was so low in part because the Commission "underwent a hiring freeze beginning in 2009 and lost personnel." E-mail from Leslie Savage, Chief Geologist, Oil and Gas Division, Railroad Comm'n of Tex., to

contribute to discrepancies in the percentage of violations that lead to enforcement, including, for example, whether site visits are conducted routinely or primarily in response to complaints; whether advance warning of inspections is provided; whether agencies face different political motivations for identifying violations and taking enforcement action; whether agencies have adequate staff to take enforcement action when violations are identified;[66] and whether industry best practices tend to vary between regions.

This section further examines the types of violations and enforcements that arose from inspections in several states with recent shale gas and tight sands development. To gather data on violations and resulting enforcement actions at shale gas wells, agency staff in approximately fifteen states were asked to provide data on all complaints, violations, and enforcements at fractured wells between approximately 2008 and 2011 or earlier if fracturing had been common for a longer time period. Some states provided no information, while others provided a wealth of data. Some of these data were not comprehensive, and some included a limited number of unfractured wells. Data from Michigan, for example, included all Antrim Shale wells; this article assumes that all of these wells were fractured. This information, though incomplete, still yields several interesting results.

In the four states for which violation and enforcement data were evaluated, the most common violations of state environmental laws at shale gas and tight sands sites involved failures to obtain permits or submit reports, failures to mow weeds around wellheads or post proper signs, improper construction or maintenance of surface pits, and surface spills of various drilling materials. These results are summarized in Table 1.

author, Feb. 27, 2012 (noting that "[u]nless a violation is egregious or an immediate threat, the RRC may allow the operator 15–30 days to correct the violation before pursuing other mechanisms, including seals and severances, legal enforcement, etc.") (on file with DUKE ENVTL. L & POL'Y F.).

66. *See, e.g.*, E-mail from Leslie Savage, *supra* note 65 (in response to a question about why enforcement actions at hydraulically fractured well sites dropped from 2008 through 2009 to 2011, explaining that "Legal Enforcement was down two attorneys" and that the Commission faced other staffing challenges).

Table 1. Most Common Violations at Shale Gas and Tight Sands Sites by Percent of Total Violations

	Louisiana[67] 2009–2011	Michigan[68] 1999–2011	New Mexico[69] 2000–2011	Texas[70] 2008–2011
Permitting & reporting	9.5%	0%	7.8%	32.3%
Pit construction & maintenance	33.2	0.2	1.3	4.8
Signs & labeling	23.7	32.5	18.2	1.6
Site maintenance	0.9	22.4	0	0
Surface spill: produced water	0.5	0.2	33.8	0
Surface spill: non-produced water or unidentified substance	3.3	24.5	5.2	0

As Table 1 shows, violations of sign and labeling requirements were the most common shared violations among the states analyzed. These violations included failures to post an identification sign with

67. Hannah Wiseman & Molly Wurzer, LOUISIANA VIOLATIONS AND ENFORCEMENTS (2011) [hereinafter LA. VIOLATIONS AND ENFORCEMENTS] (spreadsheet compiling violation and enforcement data provided by the Louisiana Department of Natural Resources in response to research assistant query) (spreadsheet on file with DUKE ENVTL. L. & POL'Y F., original data on file with author). Raw data from online database collected by Molly Wurzer. Louisiana maintains databases of compliance order initiations and compliance order paperwork; the latter is not uploaded until after a compliance order is resolved. Information on suspended compliance reports was not available.

68. Hannah Wiseman & Jeremy Schepers, MICHIGAN, NEW MEXICO, AND WYOMING VIOLATIONS AND ENFORCEMENTS (2011) [hereinafter MICH., N.M. & WYO. VIOLATIONS AND ENFORCEMENTS] (spreadsheet compiling violation and enforcement data provided by the Michigan Department of Environmental Quality and New Mexico Energy, Minerals, and Natural Resources Department in response to research assistant query) (spreadsheet on file with DUKE ENVTL. L. & POL'Y F., original data on file with author). Raw data inputted into the spreadsheet are from files provided by state agencies, including agreed orders, notices of inspection, and field activity reports, and searches of state agency online databases, including New Mexico's spill database available at https://wwwapps.emnrd.state.nm.us/ocd/ocdpermitting//Data/Incidents/Spills.aspx.

69. *Id.*

70. TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65.

the well number or signs warning of poison gas,[71] improperly located signs,[72] and a lack of visible well identification signs, among others.[73] Permitting and reporting violations, which dominated the Texas Railroad Commission's violations, appeared[74] to involve failures to obtain a permit before drilling or fracturing a well,[75] and failures to obtain approval of surface casing programs before drilling.[76] Another common procedural violation in Texas involved operators' failures to submit completion reports—which provide data about how the well was drilled and fractured and the formations encountered during the process—within ninety days of completing a well.[77]

The site maintenance issues in Michigan nearly all involved "vegetation growing near the wellhead" that needed to be removed, weeds around wellheads, and seventy-five foot areas around wellheads that were not cleared. Michigan inspectors also occasionally noted "unused machinery" on well sites that required removal.[78]

Violations with potentially substantial environmental effects included pit construction and maintenance problems. In New Mexico, for example, an inspection revealed an unpermitted pit containing waste that was over the pit liner, resulting in a $5000 fine.[79] Allowing contents in a pit to sit above the liner level can cause pit contents to seep into the soil or water around the pit.[80] In Louisiana, a pit

71. MICH., N.M. & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68.

72. *See, e.g.*, LA. VIOLATIONS AND ENFORCEMENTS, *supra* note 67, at PERMIT NO. 237610 (noting incorrectly placed "[w]ell sign on rear entrance to well").

73. *See, e.g.*, MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68 (listing 73 violations for "no visible well identification signs").

74. Texas violation data do not provide field inspector notes but rather list the regulation(s) violated.

75. TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65, at PERMIT NOS. 0637567, 232848, 233600, DOCKET NOS. 09-0259689, 09-0259690 (noting that a permit was issued after the operator paid a $14,500 penalty, and noting a violation of 16 Tex. Admin. Code 3.5C).

76. *Id.* at PERMIT NOS. 226145, 226156, 0626246; DOCKET NO. 09-0251997 (noting violations of 16 TEX. ADMIN. CODE §§ 3.5C, 3.13(b)(2)(A)(I)).

77. TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65.

78. MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68, PERMIT NO. 46116.

79. *Id.* at PERMIT NO. 30-045-32300.

80. For all well sites (including those at which fracturing may not have occurred), New Mexico maintains a list describing "cases where pit substances contaminated New Mexico's groundwater," which in 2008 contained more than 200 active cases of groundwater contamination. *See* N.M. ENERGY, MINERALS & NATURAL RES. DEP'T, OIL CONSERVATION DIV., CASES WHERE PIT SUBSTANCES CONTAMINATED NEW MEXICO'S GROUNDWATER, DATA (as of Sept. 12, 2008), *available at* http://www.emnrd.state.nm.us/ocd/documents/

containing drilling wastes[81] similarly lacked adequate freeboard—space in the pit above the waste to prevent overflow—and staff noted "excessive accumulation of produced water, waste oil, and trash in [the] reserve pit."[82] In other cases in Louisiana, oil tank seal valves were "not equipped with the proper locking and sealing devices,"[83] and various levels of pollutants like selenium or arsenic in reserve pits exceeded regulatory levels when the pits were tested at closure.[84]

Of perhaps more concern than leaking pits are the high percentage of violations in several states associated with surface spills.[85] The spills arose from a number of incidents, including malfunctioning[86] and frozen tanks[87] in New Mexico that released produced water, and an overflowing tank that spilled 142 barrels of produced water, only 70 of which were recovered.[88] In Louisiana, an operator used tanks intended for fracturing substances to store produced water; a "gauging error" caused an overflow, and the produced water migrated into a "ditch and swampy area."[89] Incidents in Pennsylvania, although not yet comprehensively analyzed to indicate the most common types of violation, also involved a number of spills, including discharges of ethylene glycol to a well pad and

GWImpactPublicRecordsSixColumns20081119.pdf.

81. The violation referred to a reserve pit, and reserve pits typically contain drilling wastes. *See* 16 TEX. ADMIN. CODE § 3.8 (2011) (defining a reserve pit as a "[p]it used in conjunction with drilling rig for collecting spent drilling fluids; cuttings, sands, and silts; and wash water used for cleaning drill pipe and other equipment at the well site").

82. LA.VIOLATIONS AND Enforcements, *supra* note 67, at PERMIT NO. 239783.

83. *Id.* at PERMIT NO. 240741.

84. *Id.* at PERMIT NOS. 240662, 238448, 238637, 239603 (indicating violations of 43:XIX LA. ADMIN. CODE § 313).

85. Indeed, the percentage of spill violations in Texas may be underreported, as some violations of 16 Texas Administrative Code § 3.8d, involving improper storage or disposal of oil and gas wastes, may represent spills. *See* 16 TEX. ADMIN. CODE § 3.8(d) (providing accepted and prohibited types of pits and disposal methods); TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65 (describing Texas Railroad Commission violations, which described § 3.8(d) violations without explaining the specific activity that caused the violations).

86. MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68, at PERMIT NO. 30-045-33599, INCIDENT NO. nRMD0931632498; PERMIT NO. 30-039-30192, INCIDENT NO., nBP0804351507.

87. *Id.* at PERMIT NOS. 30-039-26070, INCIDENT NO. nDGF0503437776; 30-039-25478, INCIDENT NO. nBP0918932635.

88. *Id.* at PERMIT NO. 30-039-25947, INCIDENT NO. nDGF0100955815.

89. LA.VIOLATIONS AND ENFORCEMENTS, *supra* note 67, at PERMIT NO. 238585.

flowback to a drainage ditch,[90] small drilling-fluid spills,[91] and a fifteen-gallon spill of diesel to a well pad.[92]

Taken together, these state violations raise several issues. Each state tends to have a different category of most common violation, suggesting a number of possible reasons for variance: the types of operators drilling wells, assuming large operators with more experience cause fewer violations;[93] climate and other local factors, assuming states with more precipitation may experience more pit overflows; different agency focuses and capabilities; or a lack of adequate testing or monitoring equipment to identify problems such as soil and water contamination or air pollution. Notably, all of the most common violations are readily identifiable via a quick survey of the site. Although other incidents, such as groundwater contamination and air quality impacts, may in fact occur less often, these violations' lower frequencies may also be a function of their difficulty to detect. State agencies should consider the effectiveness of their inspections at assessing the full range of effects, including those that are not readily identifiable.

States should not expect that their overburdened agencies will adequately monitor thousands of new well sites—and new technologies—with existing staff. Agencies and legislatures alike must consider creative solutions for raising funds, such as Pennsylvania's approach of increasing permit fees,[94] to ensure that agencies have the capacity to inspect in the first place. While this point is frequently noted, it cannot be overemphasized.

Another source of variation among the states, discussed below, involves the range of enforcement actions taken in response to these violations, which has important implications for deterrence, agency funding (in states agencies that are partially funded through fees and penalties), and industry's internalization of the environmental costs created by drilling and fracturing.

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90. PA. VIOLATIONS AND ENFORCEMENTS, *supra* note 62, at PERMIT NO. 035-21179.

91. *Id.* at PERMIT NO. 035-21229.

92. *Id.* at PERMIT NO. 035-21178.

93. This assumption may not always hold true. In Texas, for example, 16 of the 51 Railroad Commission violations noted between 2008 and 2011 for fractured wells involved XTO Energy, an ExxonMobil subsidiary. *See* TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65; XTO ENERGY, http://www.xtoenergy.com/en/home.html (last visited Apr. 10, 2012).

94. *See* text accompanying *supra* notes 54–55.

II. ENFORCEMENT

When states note a violation of a regulation, they do not always follow up with enforcement,[95] therein creating variations among states that echo differences in violations noted. In 2011, for example, Pennsylvania assessed more than 1000 violations in the Marcellus Shale yet took only 213 enforcement actions.[96] Of the violations identified in New Mexico's tight sands, a noncomprehensive set from 2000 through 2011, approximately 21% resulted in clear enforcement, such as a penalty or compliance order, and about 17% resulted in less formal enforcement—records for these latter violations indicated only that compliance was "resolved."[97]

Several factors likely contribute to variations in enforcement among states. First, states record violations and enforcements differently. Pennsylvania maintains a relatively comprehensive list,[98] while records for Texas only include violations that led to enforcement.[99] Second, in some cases, operators quickly fix problems noted by inspectors,[100] thereby mooting any necessary enforcement, unless states wish to issue a penalty to deter future violations. In other cases, agencies do not have independent powers to issue penalties and thus may engage only in limited enforcement, such as entering into compliance orders.[101] In New Mexico in 2009, for example, the state supreme court interpreted New Mexico's statutes to prevent the Oil Conservation Commission from issuing its own civil penalties for environmental violations; penalties had to be sought

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95. For a comparison of violations, numbers of fines, total amounts fined, and other enforcement data in twelve states, see *Ground Rules: Managing America's Oil & Gas Boom*, E&E NEWS, Dec. 20, 2011, http://www.eenews.net/special_reports/ground_rules (last visited Apr. 10, 2012). For the definition of enforcement followed in this article, *see supra* note 62.

96. PA. VIOLATIONS AND ENFORCEMENTS, *supra* note 62.

97. MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68.

98. *See, e.g.*, PA. VIOLATIONS AND ENFORCEMENTS, *supra* note 62.

99. *See* TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65.

100. *See. e.g.*, MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68, at PERMIT NO. 30-045-29580, INCIDENT NO. nRMD1010239182 (noting that "gasket on compressor released natural gas," that a violation was noted, and that the problem was "immediately corrected"); E-mail from Leslie Savage, *supra* note 65.

101. *See, e.g.*, N.M. CODE R. § 19.15.5.10(E) (allowing the director of the Oil Conservation Division to "enter into an agreed compliance order with an entity against whom compliance is sought to resolve alleged violations of any provision of the Oil and Gas Act"). Marbob Energy Corp. v. N.M. Oil Conservation Comm'n, 206 P.3d 135, 137 (N.M. 2009), invalidated this provision's granting of penalty issuance authorities to the division but did not appear to remove other enforcement authorities. *See id.* at 143 (only invalidating the portion of the code "pertaining to the Commission's and the Division's authority to impose penalties").

through the attorney general.[102] The Texas Railroad Commission, on the other hand, may issue penalties and even take criminal action in limited circumstances.[103]

The most important factor leading to variations among enforcements may be the type and degree of violation. A failure to obtain a permit for a deep well that poses particular casing challenges, for example, could be far more serious than a permitting omission for another well. Similarly, spills of unknown contaminants may be toxic or benign, with no indication in the violation data.

The range of enforcement actions taken by states in response to violations is summarized in Table 2, with the highest penalty for each state in each category shown, where available.

Table 2. Enforcement Actions: Examples of Violations and Penalties

	Louisiana	Michigan	New Mexico	Texas
Permitting & reporting	Failure to obtain work permit before completing well, file completion report, etc. Agreed order, $1000[104]	Violations noted No known enforcement from data provided	Failure to obtain permit to produce and transport gas Agreed order, $23,500	Failure to obtain permit before drilling well Agreed order, $14,500[105]
Pit construction & maintenance	High levels of arsenic, selenium, etc. at reserve pit closure Admin. order to take appropriate remedial action[106]	Violations noted No known enforcement from data provided	Water above liner in pit Agreed order, $5000[107]	Apparent failure to properly dewater, backfill reserve pit Agreed order, $1000[108]

102. *Marbob*, 206 P.3d at 137 (invalidating Section 19.15.5.10(B)(2) of the New Mexico Administrative Code, which attempted to give the Commission the independent authority to issue civil penalties).

103. R.R. COMM'N OF TEX., SELF-EVALUATION REPORT, *supra* note 51, at 90.

104. LA. VIOLATIONS AND ENFORCEMENTS, *supra* note 67, at PERMIT NO. 240195.

105. TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65, at PERMIT NOS. 0637567, 232848, 233600, DOCKET NOS. 09-0259689, 09-0259690.

106. LA. VIOLATIONS AND ENFORCEMENTS, *supra* note 67, at PERMIT NOS. 240662, 238448.

107. MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68, at PERMIT NO. 30-045-32300.

	Louisiana	Michigan	New Mexico	Texas
Signs & labeling	Improper I.D. of well site and tank battery Admin. order to post correct sign[109]	Violations noted No known enforcement from data provided	Failure to display well sign Agreed order, $1000[110]	No violations identified
Site maintenance	No violations identified	Violations noted No known enforcement from data provided	No violations identified	No violations identified
Surface spill: produced water	Salt water load line from production facility left open Admin. order to report clean-up methods[111]	Violations noted No known enforcement from data provided.	Spills of 15, 30, 60 barrels e.g. notices of violation[112]	No violations identified
Surface spill: unidentified substance	No violations identified	Violations noted No known enforcement from data provided.	Small leak of unidentified substance e.g. phone call[113]	Improper disposal violation that required spill clean-up Agreed order, remediation and $15,000[114]

As Table 2 illustrates, given the broad categories in the data provided by state agencies, the variability of violations within each category is significant. Yet both the violation and enforcement data can only tell us so much. More and better data are needed to fully assess the range of actions that states are taking to control and

108. TEX. VIOLATIONS AND ENFORCEMENTS, *supra* note 65, at PERMIT NO. 0612459, DOCKET 09-0254013.

109. LA. VIOLATIONS AND ENFORCEMENTS, *supra* note 67, at PERMIT NO. 239513.

110. MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68, at PERMIT NO. 30-031-21067.

111. LA. VIOLATIONS AND ENFORCEMENTS, *supra* note 67, at PERMIT NO. 23983.

112. MICH., N.M., & WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68, at PERMIT NO. 30-039-26101, VIOLATION NO. DGF0406442833; PERMIT NO. 30-045-30351, VIOLATION NO. DGF0327357057; PERMIT NO. 30-045-31000, VIOLATION NO. DGF0327357057.

113. *Id.* at PERMIT NO. 30-045-30929, VIOLATION NO. RMD0918334882.

114. R.R. COMM'N OF TEX., DOCKET NO. 09-0256803 (June 2008), *available at* http://info.sos.state.tx.us/pls/pub/pubomarchive$omarchive.queryview?P_OM_ID=106201&Z_CHK=29227.

mitigate the effects of shale gas and tight sands development. As the Texas Railroad Commission notes, "[t]he [Railroad Commission] has a vast store of information that is useful to industry and to the public. Unfortunately most of this information is in paper or microfilm records that must be copied or viewed in person."[115] Similarly, the Arkansas Public Policy Panel, in a report that summarizes more than 500 violations at Arkansas Fayetteville Shale wells between 2006 and 2011, argues that the Arkansas Department of Environmental Quality should make information on enforcement and violations "readily available to citizens" and should improve its recordkeeping.[116] It notes that many files, for example, do not contain any information on staff follow-up after staff initially noted a violation.

Indeed, expanded sources of data would benefit all involved. They would allow state agencies to show the efforts that they are taking to record and prevent environmental damage—as the Pennsylvania Department of Environmental Protection[117] and New Mexico Oil Conservation Commission[118] already do on their websites—and it would allow the public to assess progress. Additionally, industry would have a better idea of the types of violations that tend to occur and how to avoid them. Publishing enforcement data, in particular, could have a deterrent effect. Unfortunately, the agencies that have the data are already overwhelmed by the responsibilities of inspecting new wells, issuing enforcements, and, in some cases, revising regulations. More funding is necessary to support these substantive efforts as well as to improve datasets.

Overall, although agencies' enforcement and inspection capacities vary, the violations discussed in part I.B., above, show that states are, to different degrees, striving to apply the regulations for which they are responsible and to take enforcement actions where appropriate. The regulations that tend to dominate inspection, violation, and enforcement records, however, suggest that some of the

115. R.R. COMM'N OF TEX., SELF-EVALUATION REPORT, *supra* note 51, at 14.

116. ARKANSAS PUB. POL'Y PANEL, VIOLATIONS OF WATER QUALITY STANDARDS FROM GAS PRODUCTION IN ARKANSAS 8 (2011), *available at* http://arpanel.org/content/Violations%20of%20Water%20Standards.pdf.

117. *See* PA. DEP'T OF ENVTL. PROT., MARCELLUS SHALE: TOUGH REGULATIONS, GREATER ENFORCEMENT (2011), *available at* http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-84024/0130-FS-DEP4288.pdf.

118. *See, e.g.*, N.M. ENERGY, MINERALS & NATURAL RES. DEP'T, *supra* note 80 (showing a list of surface pits that have contributed to groundwater contamination in New Mexico).

oil and gas regulations most commonly applied are not grounded in environmental protection,[119] and that states are not prioritizing certain regulations in their inspection efforts. This is understandable in light of agencies' sometimes conflicting mandates to ensure oil and gas conservation, protect various mineral rights, and protect the environment. While these are all worthy goals, it is possible that the focus on conservation and mineral rights protection sometimes displaces efforts to ensure environmental protection.[120] This may be problematic as hydraulic fracturing allows for the development of thousands of new wells around the country, thus substantially expanding the risk of negative environmental impacts.

CONCLUSION

Hydraulic fracturing for natural gas and oil in shales has changed the American energy landscape and has immensely expanded state responsibilities for environmental protection. States have core regulatory authority over drilling and fracturing operations, and as the number of wells drilled has quickly risen, many agencies face overwhelming responsibilities. Inspectors are traveling to well sites, noting violations, and, in some cases, taking enforcement action.

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119. Many of the violations noted, for example, are associated with failures to obtain a permit prior to well development or the sale or transportation of gas and failures to post adequate signs on sites. *See, e.g.*, MICH., N.M., AND WYO. VIOLATIONS AND ENFORCEMENTS, *supra* note 68. Regulations that require permits and signage are central to environmental protection because they put the agency on notice of the well and allow the agency to inspect the well once it is constructed. *See, e.g.*, R.R. COMM'N OF TEX., OIL & GAS FILING CHECKLIST FROM PROSPECT TO PRODUCTION, http://www.rrc.state.tx.us/forms/forms/og/checklist.php (last visited Mar. 23, 2012) (noting that operators must "[n]otify the District Office at least 8 hours prior to running and cementing surface casing"). They are also, however, intended to notify the agency of the existence of the well to allow it to carry out its other duties of ensuring oil and gas conservation (by limiting the amount of oil or gas that may be produced from the well, for example, and collecting production data) and protecting other mineral owners' rights. *See, e.g.*, 16 TEX. ADMIN. CODE § 3.37(c) (requiring a plan to be filed with the Railroad Commission that must show, among other things, "all adjoining surrounding properties and completed wells in the same field and reservoir within the prescribed minimum between-well spacing distance of the applicant's well").

120. *Cf.* Soraghan, *Protecting Oil From Water*, *supra* note 57 (noting that "many of those agencies that were in charge of controlling production are now responsible for protecting people and the environment from the industrial hazards of the industry" and quoting a West Virginia administrator as stating that the agency tasked with regulating oil and gas wells has "not evolved to a point of considering the total impact of all the activity that's going on in a given area"); Mike Soraghan, *40% of State Drilling Regulators Have Industry Ties*, GREENWIRE, Dec. 19, 2011, http://www.eenews.net/public/Greenwire/2011/12/19/1 (noting that "most of the state oil and gas agencies are expected to both police and promote the industry" and that the oil and gas regulatory system began with the "goal of controlling production and protecting oil from water rather than protecting the environment").

Some states, like Pennsylvania, have issued substantial penalties yet still experience a significant number of violations of state environmental laws. Penalties may not be adequately deterring sloppy drilling and fracturing activity, or the state may be unusually active in noting violations that other states have missed. The types of violations noted among states vary significantly, suggesting that some are simply focusing on different problems, that different companies cause different environmental harms, or that local conditions cause these harms to vary. The presence of more surface water, for example, will likely lead to more violations of state water quality laws. Enforcements also fall along a continuum, from no action to severe penalties, with variations again likely arising from a range of factors—some due to legitimate differences,[121] and others perhaps arising from insufficient agency will or capacity to enforce.

Beyond the need for improved violation and enforcement data, state legislatures should more carefully consider the roles of the agencies tasked with the bulk of oil and gas monitoring and enforcement. Oil and gas agencies often wear several hats, including ensuring that oil and gas are not wasted when produced, that neighboring owners are not unfairly drained, and, finally, that the environment is protected. In some cases, states may need to consider whether these tasks require excessive juggling on the part of agencies, or even create conflicts.[122] State agencies responsible for licensing new wells that benefit from severance taxes, at least indirectly, and other revenue from these wells also face competing incentives to encourage production while ensuring environmental protection.[123]

Some agencies may also be focusing on the wrong details, such as violations that are easy to spot. Field inspectors may easily note a missing sign at a site or an obvious spill at the surface, while other potential effects are hidden and risk being overlooked. Ensuring more thorough inspections, however, will require improved staff training and testing equipment, which raises a final, important point. Just as agencies may lack adequate resources and may be focusing on

121. *See, e.g.*, sources cited *supra* note 39 (describing states' enforcement policies and actions taken prior to formal enforcement, such as notices of violation followed by voluntary compliance).

122. *See, e.g.*, Mike Soraghan, *Drilling Regulators Pull Double Duty as Industry Promoters*, GREENWIRE, Nov. 30, 2011, http://www.eenews.net/public/Greenwire/2011/11/30/1.

123. *Cf.* Arkansas Oil & Gas Comm'n, Rule A-7, Ark. Admin. Code 178.00.1-A-7 (explaining that the Commission sets well categories, which another agency then uses to determine severance tax rates).

the wrong environmental problems, they may also lack the power to adequately enforce violations of environmental laws. Legislatures must revisit agency functions and ensure that they have the power to assess penalties of a sufficiently high amount to ensure deterrence and to make operators pay for the environmental externalities that they produce.[124] Pennsylvania offers some of the most aggressive examples of forcing polluters to pay: In February 2011, for example, it issued a total of $565,000 in civil penalties against one energy company for wetlands encroachment, erosion and sedimentation violations, and a well blowout during fracturing.[125]

As the drilling and fracturing of wells rushes forward, states are revising regulations, inspecting well sites, and translating violations into enforcement. The data set, in the meantime, continues to grow, providing more lessons about the types of effects caused by fracturing, the best means of avoiding these effects, and the violations that are being overlooked or are simply uncommon. These lessons suggest that states face a daunting task: some violations appear to have caused substantial environmental harm, yet well numbers are rising quickly and state officials often may not have the resources, the will, or the authority to keep up. This preliminary analysis of regulations as they are applied by states is in anticipation of future, more detailed work. Hopefully, data and improved analysis of existing violations and enforcement matters will provide a more thorough understanding of how to properly enforce regulations. This understanding is vital; dusty text within codes tells only a partial regulatory story.

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124. The Marcellus Shale Advisory Commission, for example, has proposed that "[c]ivil penalties for violations of the Oil and Gas Act should be increased from $25,000 to $50,000 and the daily penalty should be increased from $1000/day to $2000/day." MARCELLUS SHALE ADVISORY COMM'N, *supra* note 17, at 105. It also argues that the DEP should be able to assess penalties itself. *Id.*

125. Press Release, Pa. Dep't of Envtl. Prot., DEP Fines Chesapeake Appalachia $565,000 for Multiple Violations (Feb. 9, 2012), *available at* http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=19258&typeid=1; Mike Soraghan, *Pa. Well Blowout Tests Natural Gas Industry on Voluntary Fracking Disclosure*, N.Y. TIMES (May 4, 2011), http://www.nytimes.com/gwire/2011/05/04/04greenwire-pa-well-blowout-tests-natural-gas-industry-on-36297.html (describing Chesapeake's April 2011 well blowout during fracturing).